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Propagation of magnetosonic and whistler-mode waves from the magnetosphere and atmosphere into the ionosphere

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We summarize observations of the DEMETER spacecraft in the top-side ionosphere related to the lightning activity, to the downward propagating magnetospheric chorus emissions and to the magnetosonic harmonic ELF emissions close to the geomagnetic equator.

At the 707 km altitude of DEMETER, we have observed 3D electric and magnetic field waveforms of fractional-hop whistlers. We identify corresponding source lightning strokes and we perform multidimensional analysis of the measurements and obtain detailed information on wave polarization characteristics and propagation directions. This allows us for the first time to combine these measurements with ray tracing simulation in order to directly characterize how the radiation penetrates through the ionosphere.

We also interpret observations of low-altitude electromagnetic ELF hiss observed on the dayside at subauroral latitudes. These waves propagate with downward directed wave vectors which are slightly equatorward inclined at lower magnetic latitudes and slightly poleward inclined at higher latitudes. Reverse ray tracing indicates a possible source region near the geomagnetic equator at a radial distance between 5 and 7 Earth radii and we find that low-altitude ELF hiss contains discrete time-frequency structures resembling wave packets of whistler mode chorus. The reverse raypaths of ELF hiss are consistent with the hypothesis that the frequently observed dayside ELF hiss is a low-altitude manifestation of natural magnetospheric emissions of whistler mode chorus.

Finally, we analyze waves that propagate in the extraordinary magnetosonic mode to the ionosphere from larger radial distances close to the plane of the geomagnetic equator. These waves show a characteristic harmonic structure very similar to previously reported observations of equatorial noise in the magnetosphere. The observed mode structure is influenced by the presence of multiple ions in the plasma of the top-side ionosphere but the spectral and propagation properties suggest that these waves origin from equatorial noise generated at the ion cyclotron harmonics.